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Transitions and motivations for substance misuse in prison inmates with ADHD and conduct disorder: Validation of a new instrument

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Abstract

Introduction: There is a reasonable theoretical base for understanding the possible causes and motivation behind substance misuse and its dependency. There is a need for a reliable and valid measure that delineates the markers of substance use from its initiation, and identifies different motivations for drug use transitioning, maintenance and dependency. We addressed this gap in the UK by examining and validating the Substance Transitions in Addiction Rating Scale (STARS).

Methods: 390 male prisoners were screened for conduct disorder and assessed with a clinical diagnostic interview for Attention deficit / hyperactivity disorder (ADHD). They completed the four STARS subscales regarding their substance use. Exploratory Structural Equation Modelling was performed to assess the STARS structure and to derive factors to assess validity against ADHD and conduct disorder diagnostic categories.

Results: Each of the subscales produced meaningful and reliable factors, which supported the self-medication and behavioural disinhibition hypotheses of substance use motivation. The findings robustly show that ADHD is significantly associated with the need for coping as a way of managing primary and comorbid symptoms, but not conduct disorder. The findings were strongest for the combined ADHD type.

Discussion: The STARS has a great potential to further the understanding of the motivation behind substance use and its dependency in different populations.

Keywords: Drug dependence; motivations; ADHD; conduct disorder; transitions; self-medication

Findings from the Bureau of Justice Statistics shows that approximately half of all prison inmates have a substance use disorder (Mumola & Karberg, 2006). Worldwide estimates of substance use disorders (SUD) in prisons have been reported as high as 48% (Fazel, Bains, & Doll, 2006). These figures are in contrast with estimates of the general population prevalence at 9.4% (Grant et al., 2004). SUD have high societal costs (Rice, 1999; Whiteford, Ferrari, Degenhardt, Feigin, & Vos, 2015), and the burden of disease is evidenced in higher rates of morbidity and mortality (Charlson et al., 2015), due to overdosing, high-risk behaviours and other causes (Binswanger et al., 2007). Untreated substance dependence also contributes to individuals engaging in drug-related crime, which in turn may lead to recidivism (Baillargeon et al., 2010). Furthermore, in the criminal justice setting, SUD are often accompanied by insalubrious practices that lead to blood-borne pathogen infections such as Hep C and HIV (Albizu-Garcia, Caraballo, Caraballo-Correa, Hernandez-Viver, & Roman-Badenas, 2012; Burt et al., 2007; Pena-Orellana, Hernandez-Viver, Caraballo-Correa, & Albizu-Garcia, 2011).

Substance misuse is linked with higher rates of co-existing psychiatric morbidity (Abram, Teplin, McClelland, & Dulcan, 2003). A meta-analysis demonstrated an increased likelihood of having SUD among prison inmates diagnosed with attention deficit/hyperactivity disorder (ADHD), with a joint prevalence estimate of this comorbidity at 74% (Young et al., 2015). ADHD manifests as a combination of symptom clusters of inattention and hyperactivity/impulsivity, with onset prior to age 12 (APA, 2013). Considerable evidence from population surveys and follow-up studies indicates frequent co-occurrence between ADHD and SUD (Biederman et al., 2006; van Emmerik-van Oortmerssen et al., 2012). A lifetime prevalence of 23% was recently reported based on international samples of treatment-seeking adults with SUD (van Emmerik-van Oortmerssen et al., 2014).

ADHD is widespread amongst incarcerated individuals. The estimated pooled prevalence of ADHD in prison ranges between 26-30% (Young, Moss, Sedgwick, Fridman, & Hodgkins, 2014), which substantially contrasts with prevalence estimates in the general population at about 2.8-5.3% (Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007; Simon, Czobor, Balint, Meszaros, & Bitter, 2009). This dual-diagnosis has critical implications for intervention and policy, because ADHD is associated with further comorbidity (van Emmerik-van Oortmerssen et al., 2014), and moderates drug treatment outcomes with overall poorer prognosis (Levin et al., 2004).

The motivation for substance utilization remains unclear. Findings from neurobiological sciences provide context to understand core processes in the development and maintenance of addiction (Grant, Brewer, & Potenza, 2006). Generally, findings indicate that repeated and chronic use of substances causes both anatomical and functional long-standing brain alterations (Volkow & Li, 2005). Imaging studies demonstrate atypical markers in pre-frontal regions, and in their pathways to the basal ganglia-which collectively are known to be involved in dopaminergic circuitry (Wise, 2002). Dopaminergic activity is linked to reward circuits, which have been found in experimental tasks to represent processes of substance abuse and dependence in the form of impaired and impulsive decision-making abilities (Butner, 2011; Koob & Volkow, 2010; Urcelay & Dalley, 2012). Substance dependency also decreases sensitivity for the effects of rewards and affects, motivation and cognitive-control (Volkow et al., 2010), which may have implications for self-regulation.

In the context of the reward systems hypothesis, several biopsychosocial explanations attempt to explain further the motivations and maintenance of SUD. The *self-medication* hypothesis generally refers to engaging in substance misuse in order to cope with the emotional burden of symptoms. As a neurobiological formulation, it indicates that individual's recourse to substances that may aid compensation for deficiencies in the

dopamine system, thereby attempting to modulate emotional and behavioural processes via executive mechanisms of control (Silva et al., 2014). More generally this entails engaging in drug-taking behaviours as a way of coping with cognitive, psychological and emotional needs (Khantzian, 1985). Studies addressing this hypothesis have so far produced mixed results (for a review, see Young & Sedgwick, 2015). The *behavioural disinhibition* hypothesis refers to defective impulse control as the motivation underlying substance misuse. Reactive or rash disinhibition, as opposed to executive disinhibition, has been linked with SUD (Handley et al., 2011), and may be the by-product of reward sensitivity. This is exemplified by constant involvement in sensation/novelty-seeking behaviours (Faraone, Kunwar, Adamson, & Biederman, 2009). Impulsivity is widely thought to play an essential role in the initiation and development of habitual and problematic substance use (Gullo & Dawe, 2008). Meanwhile, the *comorbidity* hypothesis states that substance misuse is better explained by coexisting disorders with SUD (i.e., dual diagnoses), such as conduct disorder in youths, and personality traits, anxiety or mood disorders. A meta-analysis documented the extent of additional comorbidity present in patients with coexisting ADHD/SUD (van Emmerik-van Oortmerssen et al., 2014), lending some support to this view.

The self-medication and behavioural disinhibition hypotheses may represent independent motivations for substance use maintenance. Meanwhile, substance misuse due to comorbidity (i.e. comorbid hypothesis) may be described by the presence of internalised disorders (such as stress reactions, anxiety and mood disorders), which are commonly found in ADHD (Young & Sedgwick, 2015). For instance, comorbid symptoms of stress, anxiety, depression and low self-worth are likely to be associated with self-medication but not with behavioural disinhibition for people with ADHD.

These different explanatory models are helpful in providing a theoretical base for understanding the possible origins and motivations behind substance use and its dependency.

What is lacking in the literature is the availability of a reliable and valid measure that maps the transition of substance misuse based on motivations for use from its initiation, persistence and dependency. The current paper addresses this gap in the literature by validating a new instrument, the Substance Transitions in Addiction Rating Scale (STARS), as a measure of motivations, possible causes and transitions into addictive behaviours of psychoactive substances. The specific questions addressed were: *a*. Does the STARS have meaningful factors that are linked to theories of motivation for substance misuse? *b*. Does the STARS differentiate between subgroups that are understood to have different motivations for using substances?

We therefore examined the factor structure and validity of the STARS' four sequential substance use subscales from initial to continued drug use. In order to evaluate its utility in a clinical context, the magnitude of associations with ADHD and conduct disorder were estimated.

Methods

Participants and sample selection

The sample was recruited by convenience sampling from Inverness Prison, Porterfield (Scotland, UK) over a period of 18 months. The sample was predominantly 'White British', with a mean age of 30.3 years. Out of the 96 (24.6%) prisoners who were diagnosed with ADHD in the current study, 15 (15.6%) reported having previously received pharmacological treatment for ADHD. Lifetime substance use endorsement in the sample was: alcohol 386 (99.7%), heroin 175 (45.2%), cocaine 302 (78.0%), crack-cocaine 140 (36.2%), amphetamine 286 (73.9%), cannabis 359 (92.8%) and ecstasy 304 (78.6%). Further details regarding sample selection and study procedures have been published elsewhere (Young et al., 2016).

Participants were 390 male prisoners at Inverness Prison who completed the STARS. Their median incarceration time was approximately 4 months (0.33 years), with 43%

currently remanded. Analyses were then restricted to the 364 prisoners who endorsed substance use ever. The STARS is divided in four subscales (A, B, C, D) that refer to drug use onset, persistence, reason for transition or current preferred substance (full description below). In total 364 completed STARS A, 352 completed STARS B, 339 completed STARS C and 338 completed STARS D. Demographic characteristics and descriptive statistics of the study variables are presented in Table 1.

-Insert Table 1 about here-

Measures

Substance Transition in Addiction Rating Scale(Young et al., 2016)

The STARS was developed as a self-report measure to delineate a pathway of motivations for substance misuse from its initiation to the transitioning and persistence of psychoactive substances. The STARS consists of four scales based on a query regarding a specific substance: A. *I first tried the drug because…*(initiation, 18 items); B. *I continued to use the drug because…*(maintenance, 33 items); *C. I moved on to other substances because…*(transition, 21 items); *D. I continued to take drugs because…*(substance use maintenance, 33 items). Scale C has similar items to Scale A, plus three additional items addressing reasons for transitioning to other substances; Scales B and D have the same 33 items. All item values range from 1 to 5. Individual STARS items are presented in Tables 3 and 4.

ADHD diagnosis and conduct disorder screening

All participants were screened using the Barkley Adult ADHD Rating Scale-IV (BAARS-IV)(Barkley, 2011) and interviewed using the Diagnostic Interview for ADHD in Adults 2.0 (DIVA-2) (Kooij, 2010), which is a validated semi-structured clinical interview of ADHD in adults. The DIVA-2 is divided into categories of inattention and hyperactivity/impulsivity. Questions address their current and childhood (i.e. ages 5 to 12)

presentation of symptoms and inmates were classified according to DSM-5 criteria. Meeting the impairment criterion was required to establish ADHD diagnosis.

Conduct disorder was screened using the conduct disorder scale of the BAARS-IV, which corresponds with DSM-5 criteria, with endorsement of three or more criteria indicating likelihood of the disorder.

Procedures

The researchers developed the conceptual work for the STARS items over a series of meetings. Items were generated in consultation with a working group with the purpose of developing a scale to delineate the motivations and pathways of drug use and its continuance. This included experts working in both addiction and forensic mental health services. The scale was piloted in six service users, drawn from addiction and forensic services at the South London and Maudsley NHS Trust (SLaM). Feedback was obtained from the service users that the STARS scales were acceptable to them, and feasible for use in complex services. Following the feedback, some of the items were simplified. No items were added or deleted. All aspects of the process and the development of the STARS scales were performed observing applicable standards for educational and psychological testing (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014).

The Scottish Prison Service approved this research study (reference: 7/13/10/10). Participants were informed about the study by flyers placed on noticeboards. Those who indicated interest attended an appointment with the researcher when they were given detailed written information about the study and the consent procedures. A comprehensive battery of measures was administered, including the BAARS-IV, the DIVA-2 and the STARS. Two researchers had previously attended comprehensive training sessions at the Maudsley Hospital Adult ADHD Service to reliably administer these measures.

Analytical strategy

Frequencies were reported for all categorical variables, and means with their standard deviations for continuous descriptive variables.

A factor analysis in the context of Exploratory Structural Equation Modelling (ESEM; Asparouhov & Muthén, 2009) was performed to assess the STARS structure and to derive factors to assess validity. The decision to perform exploratory work on the STARS using ESEM followed limitations identified for our purposes using traditional factor analyses. Firstly, considering the total number of items, our sample size limited our ability to perform a random split of the sample (50:50) to conduct separate Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). Secondly, the use of CFA has the disadvantage that it requires robust measurement science that is often not available in clinical practice. In the context of examining a measure for the first time, searching for an acceptable measurement model may be better performed by EFA. Because we required standard errors for all factor loadings, indices of model fit indices, and being able to model the latent factors derived with covariates as part of the validation phase of the study, ESEM provided a better option.

Model fit was assessed by the root mean square of approximation (RMSEA, with 90% CI) and the Comparative-fit (CFI) and Tucker-Lewis (TLI) indices. Values of 0.06 or lower for RMSEA, and optimally above 0.95 for CFI and TLI indicate a very good model fit (Hu & Bentler, 1999; Yu & Muthén, 2002).

Construct validity was assessed using a Multiple Indicators Multiple Causes model. In this procedure, the effects of a covariate (e.g. grouping variable, continuous score) on a measurement model are examined in order to establish whether groups based on the covariate have differential scores on the latent factors derived (Marsh, Morin, Parker, & Kaur, 2013).

Covariates used to correlate with ESEM-derived factors were age, ADHD and its categorical subtypes, and conduct disorder.

Stata version 13 (StataCorp., 2013) was used for data management and descriptive analyses. Mplus version 7.1 (Muthén & Muthén, 2013) was used for all ESEM estimation.

Results

Model fit indices and the number of factors for each of the four STARS subscales is shown in Table 2. All indices of model fit are above the adequate thresholds for good fit, with the exception of the $\chi 2$ test, which is known to be an unreliable measure of model fit with large sample sizes (Bentler & Bonett, 1980). The STARS C ("*I moved to other substances because…"*) displays the best model fit of all STARS subscales (RMSEA 0.049 90% CI [0.040, 0.059], CFI 0.967, TLI 0.953).

-Insert Table 2 about here-

Table 3 shows the item loadings and factor solutions for the STARS A and C. STARS A ("*I first tried the drug because…*") included two factors that were named *Coping* (10 items) and *Sensation-seeking* (8 items). Examples of the highest loading items in the STARS A Factor 1- *Coping* include: *(6) I thought it would help me sleep, (11) to help me cope with feelings of restlessness,* and *(16) to help me cope with stress*. Example items for STARS A Factor 2- *Sensation-seeking* are: *(9) Because of the sensation of it,* and *(8) Because people encouraged me to do so*. Factor alphas (α) for the STARS A subscales were 0.811 and 0.711 respectively.

-Insert Table 3 about here-

The STARS C ("*I moved on to other substances because…*"), had the same factors as STARS A, with an additional three items that directly addressed reasons for substance dependence transition (e.g. *the drug I was taking wasn't enough anymore*). Results from the ESEM show a similar factor structure as the STARS A Factor 1 (i.e. *Coping* and *Sensation-*

seeking), with the additional items generating a new factor that we named *Dependency*. Alpha (α) reliability coefficients for the three STARS C subscales were 0.800, 0.781 and 0.750 respectively.

Item loadings and factor solutions for the STARS scales B and D are presented in Table 4. The subscale B ("*I continued to use the drug because…*") optimal solution derived four factors, namely *Dependency* (7 items, e.g. *I couldn't live without it*), *Sensation-seeking* (9 items, e.g. *If I didn't take it I would lose my friends*), *Acceptance* (5 items, e.g. *I enjoyed taking it and didn't want to give it up*) and *Coping* (9 items, e.g. *it helped me cope with daily life*). Alpha (α) reliability indices for STARS B factors were 0.845, 0.717, 0.706 and 0.883 respectively.

-Insert Table 4 about here-

Despite including the same items as STARS B, the factor configuration of STARS D ("*I continued to take drugs because…"*) differed slightly. The four STARS D factors were *Dependency* (14 items), *Coping* (4 items), *Sensation-seeking* (10 items) and *Acceptance* (3 items), with alphas (α) of 0.921, 0.774, 0.813 and 0.634 respectively.

-Insert Table 5 about here-

Table 5 includes all results from the estimation of the effect of covariates on all STARS factors scores. For drug use initiation (STARS A), ADHD diagnosis was associated with higher scores on *Coping* and *Sensation-seeking* factors. In terms of substance use maintenance (STARS B), ADHD was associated with *Coping* but not with *Sensation-seeking* or *Acceptance*. On the drug transition scale (STARS C), ADHD was significantly associated with the *Coping* and the *Dependency* factors, but not with *Sensation-seeking*. For substance use maintenance, STARS D, ADHD was significantly associated with the *Coping* and *Dependency* factors.

After including conduct disorder on all models, the association between ADHD and the *Sensation-seeking* (STARS A) factor was attenuated, suggesting coexisting conduct disorder better explained this factor. We observed adjusted direct associations between conduct disorder with *Sensation-seeking* (STARS A), *Acceptance* (STARS B) and *Dependency* (STARS D) factors.

ADHD subtype classification analyses show that associations between ADHD and factors were highest for the combined symptoms of inattention and hyperactivity-impulsivity type. Among this group, there were higher associations with *Acceptance* and *Sensation-seeking* maintenance factors, on STARS B and D respectively. Among those with primary inattentive type, associations were restricted to *Coping* and *Dependency* on STARS C, and to *Dependency* in STARS D, whereas those with primary hyperactivity/impulsivity type did not have significant associations on any of the factors.

Discussion

This study set out to examine and validate the STARS as a measure of possible origins, motivations, and pathways into addictive behaviours of psychoactive substances. Construct and clinical validation was performed by examining associations with ADHD diagnosis, a neurodevelopmental disorder known to be a strong correlate and risk factor for SUD, after considering the potential influence of comorbid conduct disorder. Corresponding with ADHD diagnostic classifications, the STARS factors on the four subscales were analysed in terms of ADHD symptom dimensions of inattention, hyperactivity/impulsivity, and combined presentation.

There were three key findings. First, exploratory work on the four STARS subscales produced a series of factors that were meaningful, reliable and consistent with existing theory. For example, the coping and behavioural disinhibition items loaded on separate factors. Secondly, there were subtle differences in the motivation for drug taking across

substance use initiation, maintenance of drug taking, and transition to other drugs. For example, the continuation of taking the initial drug was associated with psychological and physical dependence on the substance, which resulted in the need to try further drugs, leading in most instances to substance use maintenance. This suggests that it is important to look at each of the four sequential steps individually for clinical and research purposes.

Thirdly, ADHD was significantly associated with the coping factor, which is consistent with the concept of self-medication, but also contained features of the comorbid hypothesis (e.g., managing stress, anxiety and mood). The findings were most robust for those with a diagnosis of the combined type, however, salient differences emerged between the primary inattentive and hyperactive/impulsive types. For example, the inattentive type had a much stronger need for a new drug during the substance use transition phase (i.e., "*Because the drug I was taking wasn't enough anymore*"), and as a way of managing feelings of worthlessness, hopelessness and dependency during the substance use maintenance phase. This may be due to difficulties associated with inattention being more persistent than hyperactivity/impulsivity in adulthood. This differential in motivational effects by ADHD subtypes merits further research.

To our knowledge, this is the first study to examine the self-medication hypothesis in the pathway to SUD among patients with ADHD using a reliable and operationalized definition of the construct. It was found that ADHD was linked primarily with factors representing self-medication, many of which indicated coexisting disorders, e.g. *without it I felt hopeless about the future* (depression), *to help me cope with stress* (stress/anxiety). Both depression and anxiety are two of the most frequent correlates with ADHD generally (Biederman et al., 2006; van Emmerik-van Oortmerssen et al., 2014) and in prison (Gonzalez, Velez-Pastrana, Ruiz Varcarcel, Levin, & Albizu-Garcia, 2015). In this context, further research should examine how much variance is explained by comorbid disorders,

using a structured approach and longitudinal-experimental designs that allow for testing moderators and mediators.

Specific associations between ADHD and the STARS factors were partly determined by the stage of the transition. For instance, ADHD diagnosis was significantly associated with sensation-seeking traits but only in terms of substance use initiation. This suggests that sensation-seeking influences people with ADHD to try out drugs in the first instance, but it then ceases to be important and coping needs and dependency dominate the reason for continuing to use the first drug, trying out new drugs, and substance use maintenance. This could explain why the use of crack cocaine and heroin are so prominent among prisoners with ADHD (Young, Wells, & Gudjonsson, 2011). Nevertheless, consistent with previous research (Lynskey & Hall, 2001), our adjusted models revealed that any link between sensation-seeking items factors and ADHD was better explained by comorbid conduct disorder.

Factor items are not identical across scales, nor do the factors labels mean that the factors represent only one construct. For instance, items related to social influences and peer pressure clearly loaded on the Sensation-seeking factors, suggesting that these processes are related. Also, the composition of the factors themselves changes along the transition in terms of drug misuse. Individuals who progress through substance misuse motivations that were related to coping become linked with dependency issues later on. This leads to the key message that if the progression from substance use initiation through the pathway is related to coping, rather than sensation-seeking (or peer-pressure), the risk for developing substance dependence may be higher.

Limitations

A key strength of the study is the sample size and a methodology in which every participant underwent a detailed diagnostic clinical interview of ADHD. However findings

may not be generalizable beyond the prison population, and although SUD in this context is exceedingly high, validation of the STARS scales is advised for other substance-dependent and clinical samples. The present study did not include females who may present as clinically distinct from community females, in terms of comorbidity, severity and impairment. When employing rating scales, limitations arise in relation to the subjectivity, reliability and accuracy of self reports, as well as the psychometric construction of the scales themselves (Naglieri & Goldstein, 2014). Finally, our cross-sectional design limits any causal interpretations of the association between ADHD and its symptoms and the STARS factor scores.

Concluding remarks

The present study shows that the STARS reliably measures different motivational factors involved in the path from initial drug taking to substance use maintenance. The STARS has great potential to further the understanding of the motivation behind substance use and its dependency among different populations for clinical and research purposes. In the current study, the findings clearly show that ADHD is significantly associated with the need for self-medication as a way of managing primary and comorbid symptoms. The findings were strongest for the combined ADHD type.

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Table 1. Descriptive statistics and frequencies of Inverness (UK) prison sample

	*N*º	%		*N*º	%
STARS A	364	-	STARS C	339	-
Age (yrs.)			Age (yrs.)		
18-23	99	27.2	18-23	93	27.4
24-28	94	25.8	24-28	89	26.3
29-37	87	23.9	29-37	84	24.8
38-50	84	23.1	38-50	73	21.5
ADHD	92	25.3	ADHD	87	25.7
CD	151	41.5	CD	148	43.7
STARS B	352	-	STARS D	338	-
Age (yrs.)			Age (yrs.)		
18-23	96	27.3	18-23	92	27.2
24-28	93	26.4	24-28	89	26.3
29-37	83	23.6	29-37	83	24.6
38-50	80	22.7	38-50	74	21.9
ADHD	92	26.1	ADHD	87	25.7
CD	151	42.9	CD	148	43.8

Note: STARS-Substance Transition in Addiction Rating Scale, ADHD – Attention Deficit / Hyperactivity Disorder, CD-Conduct Disorder.

Table 2. *Exploratory Structural Equation Model (ESEM) fit indices of STARS subscales*

Version	*N*º factors	Chi sq. (*df*)	RMSEA	RMSEA 90%CI	CFI	TLI
STARS A (*18 items*)	2	247.1 (118)*	0.055	[0.045, 0.064]	0.959	0.947
STARS B (*33 items*)	4	766.4 (402)*	0.051	[0.045, 0.056]	0.967	0.957
STARS C (*21 items*)	3	274.4 (150)*	0.049	[0.040, 0.059]	0.967	0.953
STARS D (*33 items*)	4	837.4 (402)*	0.057	[0.051, 0.062]	0.963	0.952

Note: RMSEA-Root Mean Square Approximation, CFI-Comparative Fit Index, TFI-Tucker-Lewis Index, STARS - Substance Transition in Addiction Rating Scale.
*$p < 0.001$

Table 3. Item factor loadings and factor structure derived from exploratory structural equation modelling (ESEM) for STARS scales A ("*I first tried the drug…*) and C ("*I moved to other substances…*").

	A: Substance use initiation (*n* = 364)		C. Substance use transition (*n* = 339)		
Factor indicators	F1	F2	F1	F2	F3
1. Because I thought it would help me relax	0.685		0.784		
2. Because my friends were doing it		0.571		0.893	
3. Out of curiosity		0.527		0.843	
4. As a way of meeting new people		0.494		0.717	
5. Because I was bored		0.550		0.738	
6. Because I thought it would help me sleep	0.845		0.991		
7. As a way of 'forgetting' all my problems	0.726		0.62		
8. Because people encouraged me to do so		0.592		0.754	
9. Because of the sensation of it		0.679		0.752	
10. To help me lose weight	0.541		-	-	-
11. To help me cope with feelings of restlessness	0.846		0.783		
12. Because I was feeling lonely	0.695		0.545		
13. To help me cope with schoolwork	0.718		0.621		
14. To help me cope with bullying	0.679		0.848		
15. Because my prescription was stopped	0.731		0.649		
16. To help me cope with stress	0.880		0.699		
17. Because the urge to do so was overpowering		0.454	-	-	-
18. As a way of rebelling (e.g. from society, parents, authority)		0.629		0.501	
Items only in STARS C					
19. Because the drug I was taking wasn't enough anymore					0.926
20. Because I needed to seek a better high					0.687
21. To cope with the effects of the first drug I took					0.571
Factor α	***0.811***	***0.711***	***0.800***	***0.781***	***0.750***

Note: STARS-Substance Transition in Addiction Rating Scale; **STARS A**, F1-Coping; F2-Sensation-seeking. **STARS C**, F1-Coping; F2-Sensation-seeking; F3-Dependency

Table 4. Item factor loadings and factor structure derived from exploratory structural equation modelling (ESEM) for STARS scales B ("*I continued to use the drug because…*) and D ("*I continued to take drugs because…*")

	B. Substance use maintenance (*n* = 352)				D. Substance use maintenance (*n* = 338)			
Factor indicators	F1	F2	F3	F4	F1	F2	F3	F4
1. I couldn't stand the thought of stopping taking it	0.703				0.765			
2. I couldn't live without it	0.745				0.786			
3. If I didn't take it I would lose my friends		0.692					0.795	
4. It helped me feel comfortable in social situations				0.633		0.415		
5. It helped me to concentrate				0.665		0.519		
6. It was a good way of making new friends		0.551					0.774	
7. I didn't think taking drugs was bad for my health.	-	-	-	-				0.473
8. It helped me cope with boredom.				0.397		0.431		
9. I didn't feel I had the mental strength to stop taking it	0.589				0.724			
10. Without it I felt worthless	0.614				0.704			
11. It made me feel better about myself				0.558			0.525	
12. I felt under great pressure from friends to take it		0.628					0.809	
13. It helped me to calm down				0.708		0.562		
14. I enjoyed taking it and didn't want to give it up			0.777					0.641
15. Without it I would have been 'nobody'		0.616					0.566	
16. Taking it was a part of my culture			0.471		-	-	-	-
17. It helped me maintain my weight loss		0.422			-	-	-	-
18. It had become an important part of my life			0.465		0.505			
19. It made me feel 'high'			0.446				0.513	
20. It gave me a feeling of confidence		0.445					0.641	
21. Without it I felt hopeless about the future	-	-	-	-	0.609			
22. It gave me energy		0.446					0.748	
23. I found it very exciting		0.564					0.792	
24. I saw no harm in taking it			0.549					0.608
25. I felt physically unwell when I tried to stop	0.662				0.873			

Note: STARS-Substance Transition in Addiction Rating Scale; **STARS B**, F1-Dependency; F2-Sensation-seeking; F3-Acceptance; F4-Coping. **STARS D**, F1-Dependency; F2-Coping; F3- Sensation-seeking; F4-Acceptance.

Table 4 (cont.). Item factor loadings and factor structure derived from exploratory structural equation modelling (ESEM) for STARS scales B ("*I continued to use the drug because…*) and D ("*I continued to take drugs because…*")

	B. Substance use maintenance (*n* = 352)				D. Substance use maintenance (*n* = 338)			
Factor indicators	F1	F2	F3	F4	F1	F2	F3	F4
26. I wanted to reach new spiritual heights		0.502					0.440	
27. I was reminded of it by certain people and areas	-	-	-	-	0.505			
28. The urge to continue was overpowering	0.561				0.806			
29. Something bad happened in my life that led to my drug use getting out of control				0.632	0.632			
30. It was a way to feel normal				0.685	0.801			
31. It was a way of forgetting all my problems				0.818	0.732			
32. It helped me to cope with daily life				0.848	0.884			
33. I tried to stop and failed	0.552				0.906			
Factor α	***0.845***	***0.717***	***0.706***	***0.883***	***0.921***	***0.774***	***0.813***	***0.634***

Note: STARS-Substance Transition in Addiction Rating Scale; **STARS B**, F1-Dependency; F2-Sensation-seeking; F3-Acceptance; F4-Coping. **STARS D**, F1-Dependency; F2-Coping; F3- Sensation-seeking; F4-Acceptance.

Table 5. Construct validity of the STARS with demographics and ADHD diagnosis, categorical subtypes and dimensional symptom scores

	STARS Factors A: Substance use initiation		B: Substance use maintenance			C: Substance use transition			D: Substance use maintenance				
Covariates	C	SS	D	SS	A	C	C	SS	D	D	C	SS	A
ADHD only[a]	**0.483*** **	**0.323***	**0.208**	**0.078**	**0.187**	**0.503*** **	**0.450** **	**0.255**	**0.484** **	**0.397** **	**0.410***	**0.284**	**-0.088**
CD Adjusted model[b]													
ADHD + CD	**0.530*** **	**0.206**	**0.217**	**0.050**	**0.034**	**0.427** **	**0.451** **	**0.217**	**0.406** **	**0.278***	**0.322***	**0.297**	**-0.068**
CD	-0.122	0.329*	-0.014	0.055	0.467***	0.238	-0.007	0.118	0.241	0.407**	-0.138	0.309	-0.044
ADHD dimensions													
Primary I/A	0.382	0.361	0.252	0.043	0.010	0.320	0.469*	0.092	0.609*	0.464*	0.324	0.173	-0.324
Primary H/I	0.487	-0.049	0.367	-0.265	-0.259	0.339	0.263	-0.172	0.063	0.266	-0.006	0.092	-0.291
Combined	0.557**	0.400*	0.138	-0.215	0.425**	0.631***	0.502**	0.470**	0.529**	0.426**	0.514**	0.401*	0.107

Note: STARS-Substance Transition in Addiction Rating Scale; **STARS A**, C–Coping; SS-Sensation-seeking. **STARS B**, D–Dependency; SS-Sensation-seeking; A-Acceptance; C–Coping. **STARS C**, C–Coping; SS-Sensation-seeking; D- Dependency. **STARS D**, D-Dependency; C-Coping; SS-Sensation-seeking; A-Acceptance. ADHD-Attention Deficit/Hyperactivity Disorder; I/A- Inattentive; H/I-Hyperactive-Impulsive; CD-Conduct Disorder

[a]Estimates adjusted for age and every other symptom cluster type.

[b]Estimates adjusted for age and include ADHD and conduct disorder simultaneously.

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Figure 1. Empirically derived factors representing the paths through substance transition specific to ADHD, conduct disorder and in the general inmate sample

All substance users	**ADHD group**	**Conduct Disorder group**
STARS A: None STARS B: *Dependency*, *Sensation-seeking* STARS C: *Sensation-seeking* STARS D: *Sensation-seeking, Acceptance*	STARS A: *Coping* STARS B: *Coping* STARS C: *Coping*, *Dependency* STARS D: *Coping*, *Dependency*	STARS A: *Sensation-seeking* STARS B: *Acceptance* STARS C: *None* STARS D: *Dependency*

References

Abram, K. M., Teplin, L. A., McClelland, G. M., & Dulcan, M. K. (2003). Comorbid psychiatric disorders in youth in juvenile detention. *Archives of General Psychiatry*, *60*(11), 1097-1108. doi: 10.1001/archpsyc.60.11.1097 60/11/1097

Albizu-Garcia, C. E., Caraballo, J. N., Caraballo-Correa, G., Hernandez-Viver, A., & Roman-Badenas, L. (2012). Assessing need for medication-assisted treatment for opiate-dependent prison inmates. *Substance Abuse, 33*(1), 60-69. doi: 10.1080/08897077.2011.620462

American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. (2014). *Standards for Educational and Psychological Testing*. Washington, DC: American Educational Research Association.

APA. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Asparouhov, T., & Muthén, B. (2009). Exploratory structural equation modeling. *Structural Equation Modeling: A Multidisciplinary Journal*, *16*(3), 397-438 doi: 10.1080/10705510903008204

Baillargeon, J., Penn, J. V., Knight, K., Harzke, A. J., Baillargeon, G., & Becker, E. A. (2010). Risk of reincarceration among prisoners with co-occurring severe mental illness and substance use disorders. *Administration and Policy in Mental Health and Mental Health*, *37*(4), 367-374. doi: 10.1007/s10488-009-0252-9

Barkley, R. A. (2011). *Barkley Adult ADHD Rating Scale-IV (BAARS-IV)*: New York, NY: Guilford.

Bentler, P., & Bonett, D. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*, *88*(3), 588-606.

Biederman, J., Monuteaux, M. C., Mick, E., Spencer, T., Wilens, T. E., Silva, J. M., . . . Faraone, S. V. (2006). Young adult outcome of attention deficit hyperactivity disorder: A controlled 10-year follow-up study. *Psychological Medicine, 36*(2), 167-179. doi: 10.1017/S0033291705006410

Binswanger, I. A., Stern, M. F., Deyo, R. A., Heagerty, P. J., Cheadle, A., Elmore, J. G., & Koepsell, T. D. (2007). Release from prison--a high risk of death for former inmates. *New England Journal of Medicine, 356*(2), 157-165. doi: 10.1056/NEJMsa064115

Burt, R. D., Hagan, H., Garfein, R. S., Sabin, K., Weinbaum, C., & Thiede, H. (2007). Trends in hepatitis B virus, hepatitis C virus, and human immunodeficiency virus prevalence, risk behaviors, and preventive measures among Seattle injection drug users aged 18-30 years, 1994-2004. *Journal of Urban Health, 84*(3), 436-454. doi: 10.1007/s11524-007-9178-2

Butner, A. (2011). Review: The neuropathology of drug abuse. *Neuropathology and Applied Neurobiology, 37,* 118-134.

Charlson, F. J., Baxter, A. J., Dua, T., Degenhardt, L., Whiteford, H. A., & Vos, T. (2015). Excess mortality from mental, neurological and substance use disorders in the Global Burden of Disease Study 2010. *Epidemiology and Psychiatric Sciences, 24*(2), 121-140. doi: 10.1017/S2045796014000687

Faraone, S. V., Kunwar, A., Adamson, J., & Biederman, J. (2009). Personality traits among ADHD adults: Implications of late-onset and subthreshold diagnoses. *Psychological Medicine, 39*(4), 685-693. doi: 10.1017/S0033291708003917

Fazel, S., Bains, P., & Doll, H. (2006). Substance abuse and dependence in prisoners: A systematic review. *Addiction, 101*(2), 181-191. doi: 10.1111/j.1360-0443.2006.01316.x

Gonzalez, R. A., Velez-Pastrana, M. C., Ruiz Varcarcel, J. J., Levin, F. R., & Albizu-Garcia,

C. E. (2015). Childhood ADHD symptoms are associated with lifetime and current illicit substance-use disorders and in-site health risk behaviors in a representative sample of Latino prison inmates. *Journal of Attention Disorders*, *19*(4), 301-312. doi: 10.1177/1087054712461690

Grant, Brewer, J. A., & Potenza, M. N. (2006). The neurobiology of substance and behavioral addictions. *CNS Spectrums*, *11*(12), 924-930.

Grant, B. F., Stinson, F. S., Dawson, D. A., Chou, S. P., Dufour, M. C., Compton, W., . . . Kaplan, K. (2004). Prevalence and co-occurrence of substance use disorders and independent mood and anxiety disorders: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Archives of General Psychiatry*, *61*(8), 807-816. doi: 10.1001/archpsyc.61.8.807

Gullo, M. J., & Dawe, S. (2008). Impulsivity and adolescent substance use: Rashly dismissed as "all-bad"? *Neuroscience & Biobehavioral Reviews*, *32*(8), 1507-1518. doi: 10.1016/j.neubiorev.2008.06.003

Handley, E. D., Chassin, L., Haller, M. M., Bountress, K. E., Dandreaux, D., & Beltran, I. (2011). Do executive and reactive disinhibition mediate the effects of familial substance use disorders on adolescent externalizing outcomes? *Journal of Abnormal Psychology*, *120*(3), 528-542. doi: 10.1037/a0024162

Hu, L., & Bentler, P. M. (1999). Cutoff criteria in fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1-55.

Khantzian, E. J. (1985). The self-medication hypothesis of addictive disorders: Focus on heroin and cocaine dependence. *American Journal of Psychiatry*, *142*(11), 1259-1264.

Koob, G. F., & Volkow, N. D. (2010). Neurocircuitry of addiction. *Neuropsychopharmacology*, *35*(1), 217-238. doi: 10.1038/npp.2009.110 npp2009110

Kooij, J. J. S. (2010). Diagnostic Interview for ADHD in Adults 2.0 (DIVA 2.0) Adult ADHD: Diagnostic assessment and treatment: Pearson Assessment and Information BV: Amsterdam, ND.

Levin, F. R., Evans, S. M., Vosburg, S. K., Horton, T., Brooks, D., & Ng, J. (2004). Impact of attention-deficit hyperactivity disorder and other psychopathology on treatment retention among cocaine abusers in a therapeutic community. *Addictive Behaviors, 29*(9), 1875-1882. doi: 10.1016/j.addbeh.2004.03.041

Lynskey, M. T., & Hall, W. (2001). Attention deficit hyperactivity disorder and substance use disorders: Is there a causal link? *Addiction, 96*(6), 815-822. doi: 10.1080/09652140020050988

Marsh, H. W., Morin, A. J., Parker, P. D., & Kaur, G. (2013). Exploratory structural equation modeling: An integration of the best features of exploratory and confirmatory factor analysis. *Annual Review of Clinical Psychology*. doi: 10.1146/annurev-clinpsy-032813-153700

Mumola, C. J., & Karberg, J. C. (2006). *Drug use and dependence, state and federal prisoners, 2004*. (Bureau of Justice Statistics Special Report NCJ 213530). Washington, DC.

Muthén, L. K., & Muthén, B. O. (2013). *Mplus user's guide.* Seventh Edition: Los Angeles, CA: Muthén & Muthén.

Naglieri, J., & Goldstein, S. (2014). Assessment of executive function using rating scales: Psychometric considerations. In S. Goldstein & J. Naglieri (Eds.), *Handbook of Executive Functions* (pp. 159-170): New York: Springer.

Pena-Orellana, M., Hernandez-Viver, A., Caraballo-Correa, G., & Albizu-Garcia, C. E.

(2011). Prevalence of HCV risk behaviors among prison inmates: Tattooing and injection drug use. *Journal of Health Care for the Poor and Underserved, 22*(3), 962-982. doi: 10.1353/hpu.2011.0084

Polanczyk, G., de Lima, M. S., Horta, B. L., Biederman, J., & Rohde, L. A. (2007). The worldwide prevalence of ADHD: A systematic review and metaregression analysis. *American Journal of Psychiatry, 164*(6), 942-948. doi: 10.1176/appi.ajp.164.6.942

Rice, D. (1999). Economic costs of substance abuse. *Proceedings of the Association of American Physicians, 111*(2), 119-125.

Silva, N., Jr., Szobot, C. M., Shih, M. C., Hoexter, M. Q., Anselmi, C. E., Pechansky, F., . . . Rohde, L. A. (2014). Searching for a neurobiological basis for self-medication theory in ADHD comorbid with substance use disorders: An in vivo study of dopamine transporters using (99m)Tc-TRODAT-1 SPECT. *Clinical Nuclear Medicine, 39*(2), 129-134. doi: 10.1097/RLU.0b013e31829f9119

Simon, V., Czobor, P., Balint, S., Meszaros, A., & Bitter, I. (2009). Prevalence and correlates of adult attention-deficit hyperactivity disorder: Meta-analysis. *British Journal of Psychiatry, 194*(3), 204-211. doi: 10.1192/bjp.bp.107.048827

StataCorp. (2013). Stata Statistical Software: Release 13. College Station, TX: StataCorp LP.

Urcelay, G. P., & Dalley, J. W. (2012). Linking ADHD, impulsivity, and drug abuse: A neuropsychological perspective. *Current Topics in Behavioral Neurosciences, 9*, 173-197. doi: 10.1007/7854_2011_119

van Emmerik-van Oortmerssen, K., van de Glind, G., Koeter, M. W., Allsop, S., Auriacombe, M., Barta, C., . . . Schoevers, R. A. (2014). Psychiatric comorbidity in treatment-seeking substance use disorder patients with and without attention deficit hyperactivity disorder: Results of the IASP study. *Addiction, 109*(2), 262-272. doi: 10.1111/add.12370

van Emmerik-van Oortmerssen, K., van de Glind, G., van den Brink, W., Smit, F., Crunelle, C. L., Swets, M., & Schoevers, R. A. (2012). Prevalence of attention-deficit hyperactivity disorder in substance use disorder patients: A meta-analysis and meta-regression analysis. *Drug and Alcohol Dependenc*e, *122*(1-2), 11-19. doi: 10.1016/j.drugalcdep.2011.12.007 S0376-8716(11)00529-1

Volkow, N. D., & Li, T. K. (2005). Drugs and alcohol: Treating and preventing abuse, addiction and their medical consequences. *Pharmacology and Therapeutics*, *108*(1), 3-17. doi: 10.1016/j.pharmthera.2005.06.021

Volkow, N. D., Wang, G. J., Fowler, J. S., Tomasi, D., Telang, F., & Baler, R. (2010). Addiction: Decreased reward sensitivity and increased expectation sensitivity conspire to overwhelm the brain's control circuit. *Bioessays*, *32*(9), 748-755. doi: 10.1002/bies.201000042

Whiteford, H. A., Ferrari, A. J., Degenhardt, L., Feigin, V., & Vos, T. (2015). The global burden of mental, neurological and substance use disorders: An analysis from the Global Burden of Disease Study 2010. *PLoS One*, *10*(2), e0116820. doi: 10.1371/journal.pone.0116820

Wise, R. A. (2002). Brain reward circuitry: Insights from unsensed incentives. *Neuron*, *36*(2), 229-240.

Young, S., Gonzalez, R. A., Mutch, L., Mallet-Lambert, I., O'Rourke, L., Hickey, N., . . . Gudjonsson, G. H. (2016). Diagnostic accuracy of a brief screening tool for attention deficit hyperactivity disorder in UK prison inmates. *Psychological Medicine, 46*(7), 1449-1458.

Young, S., Moss, D., Sedgwick, O., Fridman, M., & Hodgkins, P. (2015). A meta-analysis of the prevalence of attention deficit hyperactivity disorder in incarcerated populations. Psychological Medicine, 45(2), 247–258.

Young, S., & Sedgwick, O. (2015). Attention deficit hyperactivity disorder and substance misuse: An evaluation of causal hypotheses and treatment considerations. *Expert Review of Neurotherapeutics*, *15*(9), 1005-1014.

Young, S., Sedgwick, O., Fridman, M., Gudjonsson, G., Hodgkins, P., Lantigua, M., & Gonzalez, R. A. (2015). Co-morbid psychiatric disorders among incarcerated ADHD populations: A meta-analysis. *Psychological Medicine, 45*(12), 2499-2510. doi: 10.1017/S0033291715000598

Young, S., Wells, J., & Gudjonsson, G. H. (2011). Predictors of offending among prisoners: The role of attention-deficit hyperactivity disorder and substance use. *Journal of Psychopharmacology*, *25*(11), 1524-1532. doi: 10.1177/0269881110370502

Yu, C. Y., & Muthén, B. O. (2002). Evaluation of model fit indices for latent variable models with categorical and continuous outcomes. *Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA*.